CLAIMS

1. A buck converter comprising:

- a pair of input terminals A and B for connecting an input DC voltage Vin across these two terminals, the potential of the terminal A being higher than the potential of the terminal B;

- a pair P_0 of switches SB, SH in series and connected to the input terminal B by the switch SB, each switch SB, SH comprising a control input so that, simultaneously, one is set in a conducting state by the application of a first control signal at its control input, and the other in an isolating state by the application of a second control signal, complementary to the first control signal, at its control input;

- a pair of output terminals C and D for supplying a load Rout with an output voltage Vout, the output terminal D being connected to the input terminal B and the output terminal C to the connection point between the two switches SB and SH in series via a filter inductor Lout, characterized in that it comprises:

- K other additional pairs P_1, P_2,...P_i,..., P_K-1, P_K of switches in series between the input terminal A and the switch SH of the pair P_0, with i = 1, 2,...K-1, K, the two switches of the same additional pair P_i being connected in series via an energy recovery inductor Lr_i;

- K input groups, Gin_1, Gin_2,...Gin_i,... Gin_K-1, Gin_K, of Ni capacitors C in series, each of the same value, with i = 1, 2,...K-1, K and Ni = (K+1) - i, the electrode of the capacitors of one of the two ends of each input group Gin_1, Gin_2,...Gin_i,... Gin_K-1, Gin_K being connected to the input terminal A, at least the electrode of the capacitors of each of the other ends of the input groups Gin_1, Gin_2,...

Gin_i,...Gin_K-1, Gin_K being connected to the connection point between two pairs of consecutive switches P_(i - 1) and P_i, respectively;

- K output groups, Gout_1, Gout_2,...Gout_i,... Gout_K-1, Gout_K, of Mi capacitors C in series, each of the same value, with i = 1, 2, K and Mi = i, the electrode of the capacitors of one of the two ends of each output group Gout_1, Gout_2,...Gout_i,... Gout_K-1, Gout_K being connected to the common point between the two switches of the pair P_0, at least the electrode of the capacitors of each of the other ends of the output groups Gout_1, Gout_2,...Gout_i,... Gout_K being connected to the common point between each switch SH_i and the recovery inductor Lr_i of the corresponding pair P_i of the same rank i, respectively,

in that the switches of these other K additional pairs are simultaneously controlled by the first and second complementary control signals forming, when the switch SB of the pair P_0 connected to the terminal B is set in the conducting state for a time Toff, a first network of capacitors connected between the terminal A and the terminal B, comprising the groups of input capacitors in series with the groups of output capacitors such that a group of input capacitors Gin_i is in series, via its respective energy recovery inductor Lr_i, with its respective group of output capacitors Gout_i,

and in that, when the switch SB of the pair P_0 connected to the input terminal B is set in the isolating state, SH being set in the conducting state, for a time Ton, these other K pairs of switches form a second network of capacitors, connected between the terminal A and the output filter inductor Lout, comprising the input group Gin_1 in parallel with the output group Gout_K, in parallel with input capacitor groups in series with output capacitor groups such that an input capacitor group Gin_i is in series with an output capacitor group Gout_(i-1).

2. The buck converter as claimed in claim 1, characterized in that each additional pair P_i of the converter comprises, in parallel, a diode Sc_i in series with an impedance Z_i, the anode of the diode Sc_1 being connected to the connection point between the pair P_i and the lower pair P_i-1, the common point between the cathode of the diode Sc_1 and the impedance Z_i being connected to the common point between the switch SB_i and the recovery inductor Lr_i.

3. The buck converter as claimed in claim 2, characterized in that the impedance Z_i comprises a diode Dd in series with a resistor r, the anode of the diode Dd being connected, in the converter circuit, to the cathode of the diode Sc_i.

4. The buck converter as claimed in claim 2, characterized in that the impedance Z_i comprises the diode Dd in series with a zener diode Dz, the two cathodes of the diode Dd and the zener diode Dz being connected together, the anode of the diode Dd being connected, in the converter circuit, to the cathode of the diode Sc_i.

5. The buck converter as claimed in one of claims 1 to 4, characterized in that it does not comprise interconnections between the capacitors of the same potential level, each of the input groups Gin_i or output groups Gout_i respectively comprising a single capacitance Cea_1, Cea_2;...Cea_i...Ce_K for the input group Gin_i and Csa_1, Csa_2;... Csa_i... Csa_K for the output groups Gout_i, and in that the value of each of these input capacitances Ce_i can be deduced by the calculation of the resultant capacitance of

Ni = (K+1)-i capacitors C in series, with i = 1, 2,...K, i being the order of the input group in question:

$$
\begin{array}{ll}
Cea\_1 = C/K & i = 1 \\
Cea\_2 = C/(K-1) & i = 2 \\
\ldots & \\
Cea\_i = C/((K+1)-i) & i \\
\ldots & \\
Cea\_K = C & i = K
\end{array}
$$

in that value of each of these output capacitances Csa_i can be deduced by the calculation of the resultant capacitance of Mi = i capacitors C in series, i being the order of the output group in question:

$$
\begin{array}{ll}
Csa\_1 = C & i = 1 \\
Csa\_2 = C/2 & i = 2 \\
\ldots & \\
Csa\_i = C/i & i \\
\ldots & \\
Csa\_K = C/K & i = K
\end{array}
$$

6. The buck converter as claimed in one of claims 1 to 4, characterized in that it comprises interconnections between the capacitors of the same potential level Nv, the structure comprising a single input group Gin and a single output group Gout, the input capacitance of each of the potential levels Nin_i, i being the order of the potential level in question at the input, in parallel with its respective pair P_i, is deduced by calculating the capacitance Ceb_i equivalent to the capacitors in parallel of the level Nin_i in question, which is:

$$
\begin{array}{ll}
Ceb\_1 = C.K & i = 1 \\
Ceb\_2 = C.(K-1) & i = 2 \\
\ldots & \\
Ceb\_i = C.((K+1)-i) & i \\
\ldots & \\
Ceb\_K = C & i = K
\end{array}
$$

in that the output capacitance of each of the potential levels Nout_i, in parallel between two consecutive pairs pair P_i, P_i-1, is deduced by calculating the capacitance Csb_i equivalent to the capacitors in parallel of the level Nout_i in question, i being the order of the output potential level in question, which is:

$$
\begin{array}{ll}
Csb\_1 = C.K & i = 1 \\
Csb\_2 = C.(K-1) & i = 2 \\
.... & \\
Csb\_i = C.((K+1)-i) & i \\
..... & \\
Csb\_K = C & i = K
\end{array}
$$

7. The buck converter as claimed in one of claims 1 to 4, characterized in that it comprises combinations of capacitors in parallel for certain groups and in series for others.

8. The buck converter as claimed in one of claims 1 to 7, characterized in that it comprises K recovery transformers, the primary of a transformer of order Tr_i being connected between the two switches of the additional pair P_i, the secondary being connected, at one end, to the terminals B and D of the converter and, at the other end, to the input terminal A via a zener diode Zb_i whose cathode is connected to said input terminal A.

9. The buck converter as claimed in one of claims 1 to 7, characterized in that it comprises K recovery transformers, the primary of a transformer of order Tr_i being connected between the two switches of the additional pair P_i, the secondary being connected, at one end, to the terminals B and D of the converter and, at the other end, to the output resistance Rout via a zener diode Zb_i whose cathode is connected to said

output resistance, the transfer of energy stored in the inductor occurring toward the output load Rout.

10. The buck converter as claimed in one of claims 1 to 9, characterized in that it comprises a current return diode D across the terminals of the switch SB whose anode is connected on the side of the terminals B and D, and an output filter capacitor Cout in parallel with the load Rout between the output terminals C and D.

11. The buck converter as claimed in one of claims 1 to 10, characterized in that the 'flywheel' diodes Sc_1,...Sc_i, the diode D ensuring the current continuity in the output inductor Lout and the diodes Dd of the impedance Z_i are silicon diodes.

12. The buck converter as claimed in one of claims 1 to 9, characterized in that the 'flywheel' diodes Sc_1,...Sc_i, the diode D ensuring the current continuity in the output inductor Lout and the diodes Dd of the impedance Z_i are Schottky diodes.